7.0 Discussion

The effects of chromium supplementation on body composition and physical performance have been studied in a variety of situations, however, no single study has provided overwhelming evidence towards the efficacy of chromium supplementation in enhancement of body composition and physical performance. The findings of individual studies have been summarised and complied with this discussion to determine the efficacy of chromium supplementation.

Effects of chromium supplementation on body composition with exercise training were observed in a variety of forms (chloride, picolinate, nicotinate), dosages (range 171 to 1000 μg ·d-1) and durations (range 5.7-16-weeks), however, despite considerable research the lack of consistent results prevent clear understanding of the effect of chromium supplementation. Findings by Evans (1989) demonstrated inconsistency, indicated by an initial increase in body weight, fat mass and lean body mass in the first study, followed by a decrease in body weight, fat mass and an increase in lean body mass in the second study. Hasten et al. (1992) demonstrated that females, but not males, significantly increased body weight, with no significant change in body composition parameters. Grant et al. (1997) indicated a significant decrease in body weight when 400 $\mu g \cdot d^{-1}$ chromium nicotinate is used.

Ten studies however have been unable to demonstrate any significant effect of chromium supplementation on body composition in training individuals. Of these ten studies a select few, Hallmark et al. (1996), Lukaski et al. (1996) and

Livolsi et al. (2001), indicated small non-significant trends for groups supplemented with chromium to enhance body mass, percentage body fat or lean body mass desirably compared to placebo groups, however, these trends did not approach the significance level, $p = 0.05$.

A trend observed between the groups of studies “finding significant effect” and those “not finding significant effect” of chromium supplementation on body composition demonstrated improved scoring on the Jadad 3-item quality assessment (Appendix B) for the later group of studies. Studies “not finding significant effect” received a mean score of 3.6 out of 5 (72%), whilst studies “finding significant effect” received a mean score of 2.7 out of five (54%). Controlling for the factors of bias (randomisation of samples, double-blinding, subject withdrawals) are important factors which can influence the final results (Jadad et al. 1996). Where changes in body composition may only be marginal between two groups efforts to control bias, and other factors which heavily influence body composition, such as dietary intake of energy and physical activity, will contribute to the accuracy of the study. Studies which take appropriate steps to control bias, would potentially extend this to all aspects of study design. Therefore, with the use of the Jadad 3-item quality assessment scale, the majority of well-designed and bias-controlled studies into the effects chromium supplementation do not find significant effects on body mass or composition.

Of greatest influence could be relative chromium status of subjects, which determines whether there is a significant effect of chromium supplementation

on body composition. Chromium deficiency has been reported to develop in patients receiving long-term, total parenteral nutrition by Tsuda, Yokoyama, Morita, Nakazawa and Onishi (1998), with consequences for glucose tolerance and insulin potentiation/sensitivity. The three studies which found a significant effect did not use urinary chromium excretion, serum chromium concentration or basic dietary estimation of chromium intake to assess chromium status or the effectiveness of chromium supplementation in placebo and chromium groups. In contrast eight out of the ten studies which did not find a significant effect of chromium supplementation employed one or both of these measures to assess chromium status.

The common rationale for undertaking research into chromium supplementation is that chromium intake is insufficient in many developed populations. However, the references used are dated, ranging from 1979-1984 in the study by Kaats et al. (1996). A recently conducted study by Roussel, Andriollo-Sanchez, Ferry, Bryden and Anderson (2007) found that chromium intake was below French recommendations for the elderly (60 $\mu g \cdot d^{-1}$), however, mean chromium intake was determined as 40 $\mu g \cdot d^{-1}$, but above the adequate intake set by Trumbo et al. (2001) at 20-35 $\mu g \cdot d^{-1}$ for females and males for ages up to 70 years and beyond.

Of the eight studies which assessed the effect of chromium supplementation on physical performance, all utilised chromium picolinate as the form of supplementation and with the exception of two studies (Walker et al, 1998; and Davis et al, 2000) assessed physical performance as strength or power

defined as the maximum amount of weight which could be lifted only once (one-repetition maximum). Of all the studies which assessed physical performance, none demonstrated a significant increase associated with chromium picolinate supplementation. In addition, Campbell et al. (1999) found that the placebo group gained more strength in left and right knee-extension exercise compared to the chromium supplemented group. Combined with the non-significant find of Hallmark et al. (1996) where the placebo group improved total-body, one-repetition maximum by 118 kg (equivalent to almost 24% difference) above that of the chromium group, is suggestive of a potential inhibitory role of chromium supplementation to physical performance.

Only six studies have been conducted on the effect of chromium supplementation on body composition in free-living subjects, where exercise is not supervised or prescribed. In many respects these subjects provide an indication of the effect of chromium supplementation when used in the general population, as subjects are free to carry out their own dietary strategies and exercise training. The initial study by Kaats et al. (1996) found highly significant reductions in body weight, percentage body fat and fat weight for both 200 and 400 $\mu g \cdot d^{-1}$ chromium groups in comparison to the placebo groups. Following criticism of methodological errors (non-validated body composition technique, no control over chromium intake and high drop-out rates), which could have contributed to the significant findings a replication study was designed with modified methodology and control for bias (3/5 vs. 5/5 – Jadad score). Kaats et al. (1998) however, were unable to demonstrate

the same highly significant results. Only fat mass was found to be significantly reduced in the chromium group when compared to the placebo group. Following adjustment of the data for differences in caloric intake and expenditure between chromium and placebo groups by Kaats et al. (1998), the highly significant differences in body weight, percentage body fat and fat mass supported the findings of by Kaats et al. (1996), suggestive that the chromium group would have lost significant body weight and fat if the energy balance between the groups was the same.

Inconsistency between studies which found a significant effect of chromium on body composition is also high. Whilst Kaats et al. (1996) indicate that chromium picolinate is an effective weight loss supplement, Grant et al. (1997) found that obese females receiving 400 $\mu g \cdot d^{-1}$ chromium picolinate and gained body weight. On the basis of these two studies, chromium picolinate as a weight loss supplement is not consistent within studies which have found a significant effect. Body mass reduction or gain could be influenced by the nature of the exercise protocol, such as aerobic / endurance training (Crawford et al. 1999) or resistance training (Hasten et al. 1996). The consequences to sedentary, obese patients increasing body mass further, similar to the findings of Grant et al. (1997), could be detrimental to health.

However, the findings of Kaats et al. (1996) and Grant et al. (1997) are inconsistent with the findings of Amato et al. (2000) and Lukaski et al. (2007). Between these two, well-designed and bias controlled studies (5/5 and 3/5 Jadad score, respectively) no significant effect of chromium supplementation

is observed when high dose chromium (1000 μg · d^{-1}) supplementation is provided or when dietary chromium intake is sufficient (29 ± 2 μg chromium · d^{-1} · 2000 kcal energy intake).

The determination that chromium supplementation is ineffective in enhancing body composition or physical performance from the studies reviewed is consistent with the findings of the United States of America Federal Trade Commission (FTC), which in July 1997 filed a complaint against the claims made by Nutrition 21, Inc. The FTC (1997a) alleged that Nutrition 21 made unsubstantiated claims in relation to the effectiveness of chromium picolinate. Specifically, the FTC (1997a) claimed that Nutrition 21 did not have sound, scientific evidence to claim that chromium picolinate:

- Significantly reduces body fat;
- Causes significant weight loss;
- Causes significant weight loss without dieting or exercise;
- Causes long-term or permanent weight loss;
- Increases lean body mass and builds muscle;
- Significantly increases human metabolism;
- Controls appetite and craving for sugar;
- Significantly reduces total and LDL serum cholesterol;
- Significantly lowers elevated blood sugar levels;
- Is effective in the treatment and prevention of diabetes; and
- 90% of US adults do not consume sufficient chromium to support normal insulin function.

The decision and order made by the FTC (1997b) following the investigation was that Nutrition 21 were permitted to continue selling chromium picolinate supplements, but were ordered to stop making claims (stated on previous page) that scientific studies demonstrate the effectiveness of chromium picolinate, unless those claims were true. Future claims for the effectiveness of chromium picolinate must also be substantiated by sound, scientific evidence.